APPENDIX H

SOUTHERN PACIFIC TRANSPORTATION COMPANY
GUIDELINES FOR DESIGN OF SHORING
IN CONNECTION WITH HIGHWAY
GRADE SEPARATION CONSTRUCTION

GENERAL

Temporary sheeting and shoring for support of adjacent track or tracks during construction will not be closer than 8'-6" from the center line of the track. Excavations will not be allowed closer than 8' -6" from the centerline of the track unless specifically approved by the Office of the Bridge Engineer of the Southern Pacific Transportation Company.

SHORING DESIGN AND DRAWINGS

All drawings and calculations for shoring shall be prepared and signed by a Registered Civil Engineer. The Engineer will be responsible for the accuracy of all controlling dimensions as well as the selection of soil design. values which will accurately reflect the actual field conditions. No excavation adjacent to Southern Pacific Lines will be allowed until the drawings and calculations are reviewed and approved by the Office of the Bridge Engineer for the Southern Pacific Transportation Company.

The drawings shall contain detailsof the shoring system showing sizes of all structural members, details of connections, and embedment depth. The drawings must be complete and accurately describe the nature of the work. The drawings shall include the following:

> •plan view showing all of the proposed excavations and distances from the centerline of the track to the face of the excavation at each location.

> •section view normal to the track showing the shoring location relative to the centerline of the track and the height of sheeting and track elevation in relation to the bottom of the excavation.

A minimum of 30 days should be allowed for the Railroad's review of such drawings provided that all material are in order. No excavation will be allowed until the drawings and calculations are reviewed and approved by the Office of the Bridge Engineer for the Southern Pacific Transportation Company.

CALIFORNIA TRENCHING AND SHORING

SHORING SYSTEMS AND LIMITS OF EXCAVATION

Shoring located between 8' -6" and 10'-0" from the centerline of the track, when excavation is in natural ground or fill ground which has been placed with proof of adequate compaction control, also shoring between 8'-6" and 13'00" when excavation is on fill ground other than compaction controlled as stated above, shall be of a type where the shoring is installed in place prior to any excavation being performed, and where the excavation can be made with no possibility of disturbance or loss of soil material retained between the shoring and the track. Common shoring types fulfilling this requirement are interlocking edge steel sheet piling, tongue and groove edge precast concrete sheet piling, etc., which are driven into position prior to starting any excavation. Shoring types using lagging elements which are placed as excavation proceeds are not permitted within the limits specified in this paragraph.

Shoring outside the limits stated in the previous paragraph may be of other types such as soldier piles and lagging elements which are installed as the excavation proceeds.

Excavation pits, etc., within 13' -0" from the centerline of track shall have handrails installed. Minimum clearance from centerline-of track to the face of handrails will be 8'-6" on tangent track, and 9'-6" for track on a curve.

SOIL CLASSIFICATION

Soils to be retained as well as the soils depended upon for structural stability (passive resistance, shear strength, friction angle, etc.) shall be classified in accordance with he soil types listed in AREA Specifications Chapter 8, Part 5. This classification is to be part of the calculations. and shall be stated on the submitted plans and be verified by a Registered Civil or Geotechnical Engineer, This info&nation is in Appendix C of the Caltrans Trenching and Shoring Manual.

Where the provisions of these guidelines are more restrictive than the requirements of the Public Utilities Commission Orders, Department of Industrial Safety, OSHA, or other governmental agencies, then the above guidelines shall apply for shoring adjacentto railroad tracks of the Southern Pacific Transportation Company.

APPENDIX H

LIVE LOAD SURCHARGE

All excavations within the limits detailed in the sheet titled Shoring Requirements drawing SP5, shall be designed for Railroad live load surcharge.

All shoring designed for Railroad surcharge shall be based on Cooper E-80 live load. AREA Chapter 8, Part 20 Section C, Paragraph 2(b), refers to the Boussinesq equation as a method to determine lateral pressure values for Railroad surcharge loading. The use of the AREA Boussinesq equation is not the only method available to obtain lateral pressures. Pressures significantly less than those determined by the Boussinesq equation do not adequately consider Railroad live load surcharge. i.e. The Boussinesq equation will be used to determine the minimum lateral pressure due to Cooper E-80 live load for shoring adjacent to tracks belonging to the Southern Pacific Transportation Company. The Boussinesq equation from the above referenced section is shown in the sheet titled Shoring requirements SP15.

A minimum equipment live load surcharge to be applied is an equivalent height of soil two feet high with unit weight of 110 pounds per cubic foot.

EARTH PRESSURES

For level backfill the minimum equivalent fluid pressure of 36 pounds per cubic foot shall be used in designing the shoring. This corresponds to Type 2 soil as defined in AREA Chapter 8 Part 5, Table 5.2.5 and 5.3.2. For any other type of soils as defined in AREA Chapter 8 Part 5, Table 5.2.5 and 5.3.2 the designer of the shoring system will calculate and use the corresponding equivalent fluid pressure.

Where the internal friction angle (ϕ), or the cohesion of the soils have been ascertained by boring and tests and the values for equivalent fluid pressure have been established by a Registered Professional Engineer specializing in geotechnical engineering, then these values may be used in lieu of the tabulated values providing the ϕ and C values determined by test have been reduced by 15% to allow for the dynamic effect of train loadings on the retained materials.

The minimum values for retained soils shall be those stated for Type 2 soil, namely, unit weight of soil = 110 pcf, angle of internal friction ϕ = 30°, and cohesion = 0.

When shoring sloping soils, the sloping soil surcharge shall be computed per AREA Chapter 8, Part 5, Appendix C for the corresponding soil. This information is in Appendix C of the Caltrans Trenching and Shoring Manual.

MISCELLANEOUS

Walkways and railings shall be constructed around open excavations adjacent to the operating tracks when shoring is within 13'-0" from the centerline of the tracks. Railings shall not be closer than 8'-6" horizontally from centerline of the track.

Approval of the excavation plan does not relieve the designer and/or contractor of the ultimate responsibility and liability for the excavation plan.

The design of shoring using cantilevered sheet pile walls, or cantilevered soldier pile systems, also sheet pile or soldier pile systems using tie backs or raker struts in which the tiebacks or struts are not preloaded are considered as flexible shoring systems. Excavations which are cross-strutted to the opposite side (trench type), and the tieback or raker strut is preloaded are considered as rigid shoring systems and should be treated differently from flexible systems.

All retaining structures shall be investigated and be safe against slip circle type failure.

DESIGN STRESSES

No increase in allowable stresses is allowed.

The maximum allowable design stresses listed are based on the use of undamaged high-quality materials. Stresses and loadings shall be reduced by the Engineer if lesser quality materials are to be used.

TIMBER

The species and grade of timber or lumber used shall be shown on the drawings.

Compression perpendicular to the grain   450 psi

Compression parallel to the grain $480,000/(L/d)^2$ psi
but not to exceed 1,600 psi

Flexural stress   1,500 psi

Horizontal shear   140 psi

In the foregoing formulas, L is the unsupported length; d
is the least dimension of a square or rectangular column,
or the width of a square of equivalent cross-sectional
area for round columns.

STEEL

For identified grades of steel, design stresses, except
stresses due to flexural compression, shall not exceed
those specified in the Manual of Steel Construction as
published by the American Institute of Steel Construction
 (AISC).

When the grade of steel cannot be positively identified,
design stresses, except stresses due to flexural
compression, shall not exceed either those specified in
said AISC Manual for ASTM Designation: A-36 steel or the
following:

Tension, axial and flexural   24,000 psi

> Compression, axial (when L/r is-less than 120)
> for used steel $16,000 - 0.38 (L/r)^2$ psi
> for new steel $20,000 - 0.40(L/r)^2$ psi

Shear on gross section of web   14,500 psi

Web crippling for rolled shapes   27,000 psi

For all grades of steel, design stresses and deflections.
shall not exceed the following:

Compression, flexural   (14,400,00O)/(Ld/bt) psi
but not to exceed 24,000 psi for unidentified steel or
steel conforming to ASTM Designation: A-36 nor $0.6F_y$ for
other identified steel.

In the foregoing formulas, L is the unsupported length; d
is the least dimension of rectangular columns, or the
width of a square of equivalent cross-sectional area for
round columns, or the depth of beams; b is the width and
t is the thickness of the compression flange; r is the
radius of gyration of the member. All dimensions are
expressed in inches F_y is the specified minimumyield
stress in psi, for the grade of steel used.

Sheet Pile sections =
     2/3 tensile yield for steel
     1/3 compressive strength for concrete in
     compression. No tension allowed.

ANCHOR RODS

Tension, axial and flexural   24,000 psi

Compression, axial (when L/r is less than 120)
     for used steel $16,000 - 0.38(L/r)^2$ psi
     for new steel $20,000 - 0.40(L/r)^2$ psi

PRESTRESS STRAND OR ROD

Allowable working stress
     (Other than tieback)   0.6(Ultimate Strength)
     (Used as tieback)   0.4(Ultimate Strength)

 If strand or rod is used as a structural element and will
be in service for a long period then the structural
member must be protected from corrosion. Acceptable
protection against corrosion is grease or PVC pipe.

STEEL WIRE CABLE

Allowable working load in Lbs = $\dfrac{\text{Rated Breaking Strength}}{2.5}$

 If wire cable is used as a structural element and Will be
in service for a long period then the structural member
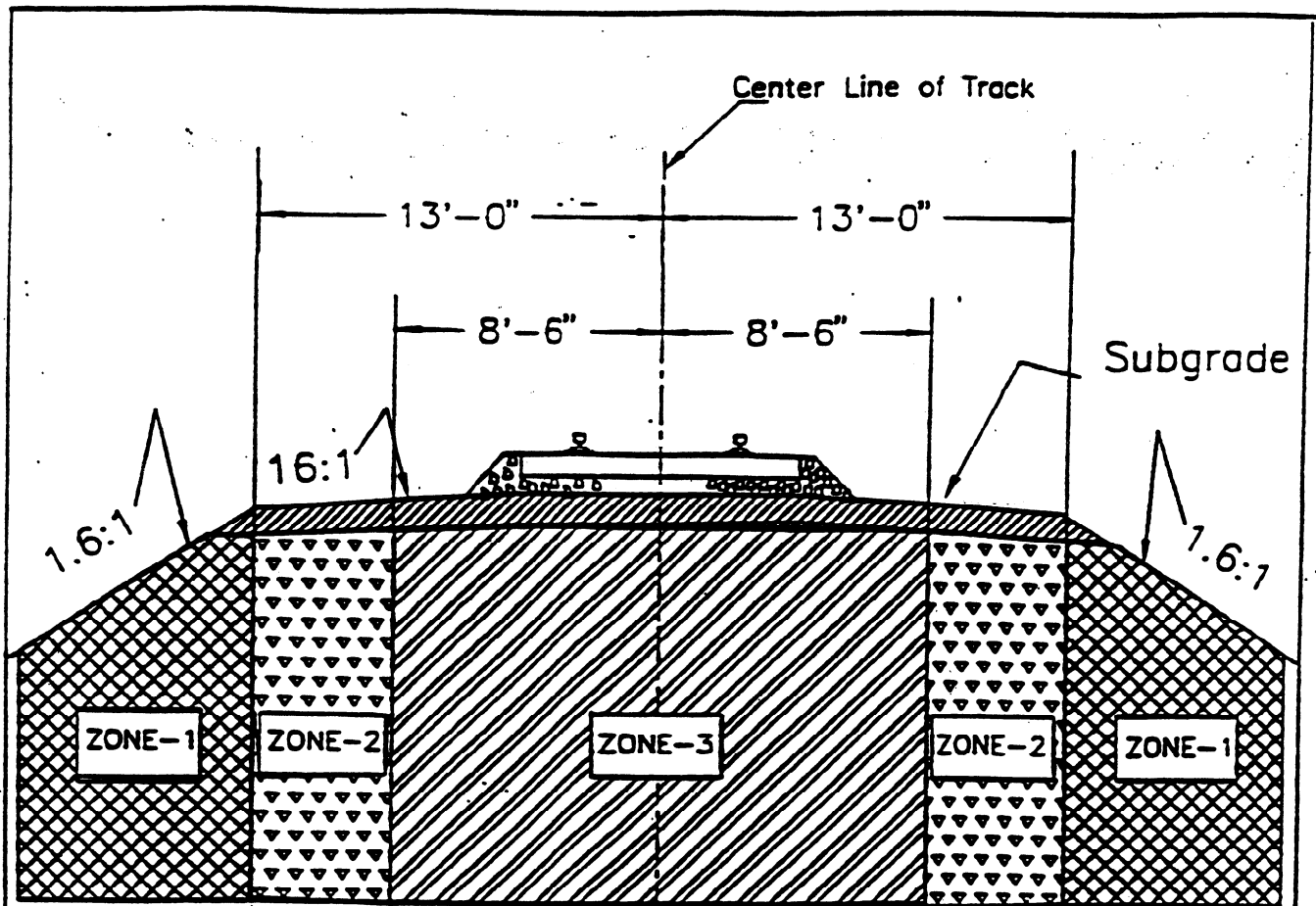must be protected from corrosion.

CONCRETE

Allowable concrete stresses shall comply with AREA
Chapter 8, Part 2.

FACTORS OF SAFETY

For anchor blocks, deadman, etc.	**2.0**
In the use of passive pressure for stability	2.0
In the use of soil shear strength and friction based on vertical loads	1.5
Slip circle failure of structure as a whole, or any part except anchor blocks, deadman, etc	1.5
Slip circle failure of anchor bolts, deadman, etc.	1.5
Soil bearing pressures	U.B.C. Section 29.

NO INCREASE IN STRESS OR REDUCTION OF SAEETY FACTORS IS
ALLOWED.

Center Line of Track

— 13'–0" — | — 13'–0" —

— 8'–6" — | — 8'–6" —

Subgrade

16:1

1.6:1

1.6:1

ZONE–1 | ZONE–2 | ZONE–3 | ZONE–2 | ZONE–1

ROADBED PROFILE

SHORING REQUIREMENTS

ZONE–1 Excavation within ZONE–1 will require shoring for protection of the Railroad.

ZONE–2 Excavation within ZONE–2 will require shoring consisting of interlocking sheeting for protection of the Railroad.

ZONE–3 NO EXCAVATION WILL BE ALLOWED IN ZONE–3

NOTE:

Excavations outside ZONE–1 may require shoring for safety. Lateral pressures due to train loadings do not affect shoring design outside of ZONE–1.

N.G.P.

SOUTHERN PACIFIC LINES

ROADBED PROFILE

SHORING REQUIREMENTS

OFFICE OF CHIEF ENGINEER

DATE 10–25–93

DRAWING: ACAD\SP5

$P_s = (2q/\pi)\ ((B+sinB)sin^2A + (B-sinB)cos^2A)$

$B = tan^{-1}\ ((CLT + TL/2)/H_s - tan^{-1}((CLT - TL/2)/H_s)$ in radians

$A = B/2 + tan^{-1}((CLT - TL/2)/H_s)$ in radians

q = uniform surcharge load from Cooper E-80 load = 80,000 Lbs/(5*TL)

CLT = Distance from face of shoring to centerline of track

TL = tie length = 9.0 ft standard

H_s = Height from bottom of tie to any point in the face of the shoring
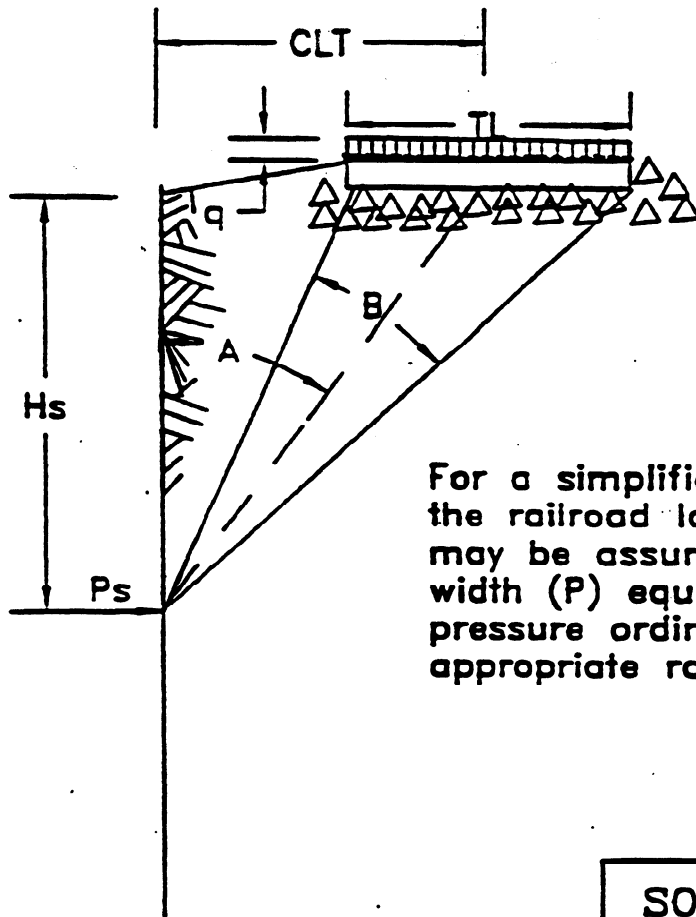
For a simplified engineering analysis, the railroad loading surcharge pressure may be assumed rectangular with width (P) equal to 0.8 of the maximum pressure ordinate as given by the appropriate railroad curve.

ALL PRESSURES SHOWN IN CHARTS ARE BASED ON BOUSSINESQ EQUATION FOR STRIP LOADS SHOWN IN A.R.E.A SPECIFICATIONS CHAPTER 8, SECTION 20 C, PART 2b

N.G.P.

SOUTHERN PACIFIC LINES

BOUSSINESQ EQUATION

RAILROAD SURCHARGE

OFFICE OF CHIEF ENGINEER

DATE 10-25-93

DRAWING: ACAD\SP15